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Transforming Sound into Knowledge

Sequence Note

Microphone Polar Plot
Substitution Method Using LinearX LT360

Introduction

This sequence measures the directional response of a microphone and graphs the result as a polar plot. A log sweep stimulus is played from 100 Hz to 10 kHz at each angular increment, and the acquired waveform is analyzed using the Time Selective Response algorithm. This method allows the test to be performed in a non-anechoic environment by placing a window around the direct signal, eliminating the influence of reflections. Commands are sent automatically to the LT360 turntable via an RS-232 connection, instructing it to move in 10 degree increments after each measurement. The sequence measures the response every 10 degrees from 0 to 180 and mirrors the polar image, which simulates a full 360 degree polar and saves test time. The response at each angular increment is compared against the on-axis response to create a normalized curve. This removes the influence of the device's frequency response and sensitivity, such that the polar plot only shows the directional response. The final display also contains a graph of the directivity index in decibels versus frequency.

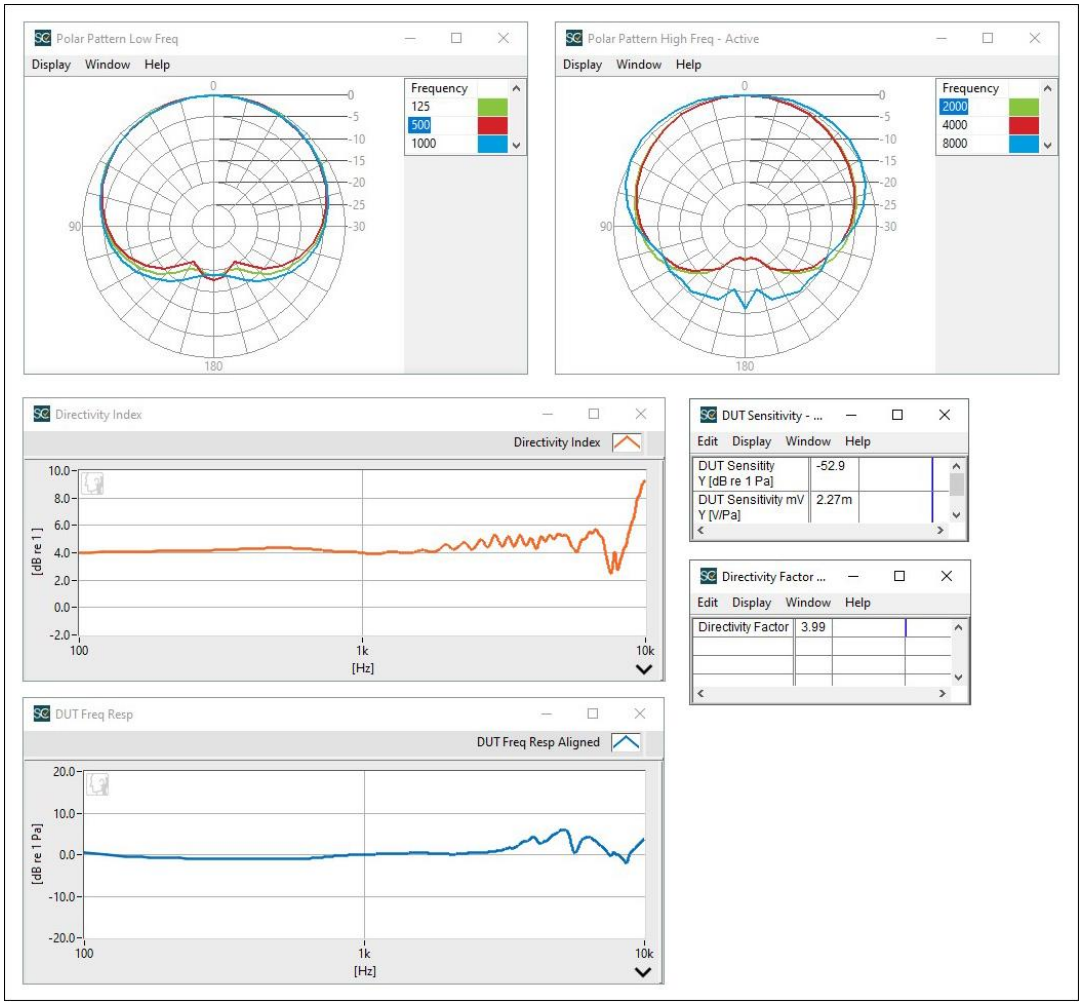

Figure 1: Final Polar Plot Display

Software Requirements

- SoundCheck 18 or later
- 2004 – Post Processing
- 2006 – Time Selective Response
- 2011 – Polar Plot

Hardware Requirements

- LinearX LT360 turntable (Requires Serial Port on PC or USB to Serial Adapter and “Straight Thru” Serial Cable)
- Genelec 8331A (powered) or KEF Q300/350 (unpowered), (or equivalent full range loudspeaker)
- Listen SC Amp power amplifier (or equivalent)
- Listen SCM-3 (or other reference microphone for calibration)
- Listen AudioConnect audio interface (or equivalent)
  If testing past 20 kHz an AudioConnect 4x4 audio interface and SoundConnect 2 microphone power supply are recommended.
- B&K 4231 calibrator (or equivalent)

Hardware Setup & Calibration

1. Connect the turntable serial connection to computer Serial Port or USB adapter.
2. Setup your RS-232 connection in the External Tab of the Hardware Editor, make sure to establish the correct COM port.
3. Connect Output 1 of the audio interface to the input of the power amplifier and connect the output of the power amplifier to the loudspeaker.
4. Connect the microphone power supply outputs to Inputs 1 and 2 on your audio interface.
5. Connect the reference microphone to input 1 of the microphone power supply.
6. Connect the DUT microphone to Input 2 of SoundConnect 2. Use a phantom power supply if the mic requires 48V power.
7. Calibrate the reference microphone as per the instructions in the SoundCheck manual.
8. Position the reference microphone at the desired test location on the turntable stand. This must match the test position of the DUT microphone.
9. Equalize the Source Speaker according to the instructions in the SoundCheck Manual: Calibration Chapter > Speaker Equalization. Even though the equalization of the source is not used in the Mic Substitution method, the calibration of the playback level of the source is.
10. You are ready to start the sequence.
11. After measuring the reference mic at the 0 degree position, the sequence will prompt you to replace it with the DUT microphone.

System diagram

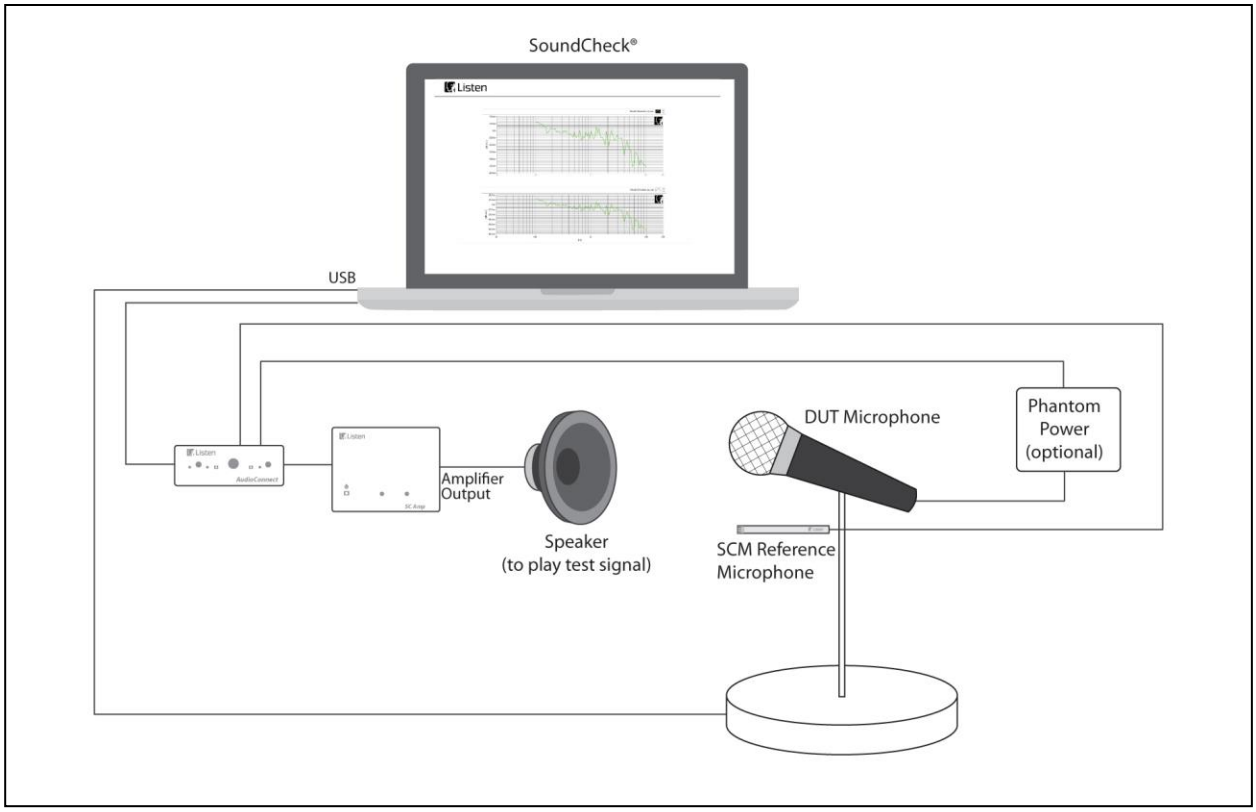

Figure 2: Wiring Diagram

Sequence Logic

Type	Step Name	#	Out	In	Comment
Mes	Recall Data	1			// Prompt to load demo data
Mes	Setup Reference Mic	2			
Mes	Linear X - Zero Turntable Warning	3			
Mes	LT360 - Zero Turntable CW	4			// Zero Turntable CW Direction
Mes	Position	5			// Sees if turntable is still rotating or not.
Mes	NO	6			// Loops until reply received is NO from turntable (stopped rotating).
Mes	Stimulus	7			
Mes	LT360 Configuration Warning	8			

Mes	LT360 - DPS	9			// Set the Step Size - Degrees Per Step - 10.0 Default
Mes	LT360 - Speed	10			// Set the Velocity (RPM) - 2.00 Default
Mes	LT360 - Acceleration	11			// Set Acceleration Function - 1 Default
Mes	LT360 - Torque	12			// Set Motor Power - 50.0 Default
Mes	LT360 - Toggle Smart Torque	13			// Toggle Smart Torque - ON Default
Mes	LT360 - Zero Turntable CW	14			// Zero Turntable CW Direction
Com	comment	15			// ---End of turntable initialization---
Mes	Position	16			// Sees if turntable is still rotating or not.
Mes	NO	17			// Loops until reply recieved is NO from turntable (stopped rotating).
Mes	Window Time Prompt	18			
Sti	Mic Polar LogSweep	19	Source Speaker		// 100 Hz - 10 kHz @ 1 Pa
Acq	Play & Record	20	Source Speaker	Reference Mic	// Acquires the on-axis data
Ana	TSR Window	21			// Sets the initial TSR Window maximum
Pos	Maximum	22			// Calculates the first reflection point from Impulse Response
Ana	TSR polar	23			
Mes	Setup DUT Mic	24			
Com	comment	25			// The measurement loop begins here
Acq	DUT Mic Acquire	26	Source Speaker	DUT Mic	
Ana	TSR polar	27			
Lim	Process 0 degrees only	28			// Checks the current angle and jumps if greater than zero
Pos	First Iteration curve copy	29			// Creates a copy of the first curve, on-axis response
Pos	DUT Mic Resp	30			
Lim	Curve - Aligned Data	31			
Pos	Sensitivity dBV	32			
Pos	Sensitivity mV Pa	33			
Pos	On-Axis Normalization	34			// Compares the current measurement to the on-axis (normalizes)
Pos	Curve copy	35			
Lim	Skip Last Acquisition	36			// Checks the current angle, exits the loop after 180 degrees
Mes	LT360 - Rotate CCW	37			// Rotates the Turntable one step - CCW Default
Mes	Position	38			// Sees if turntable is still rotating or not.
Mes	NO	39			// Loops until reply received is NO from turntable (stopped rotating).
Dis	Microphone Polar Plot	40			
Mes	End of Loop	41			// Just a logic step for looping

Mes	LT360 - Home Speed	42	// Max Velocity when Zero Turntable
Pos	Directivity Index	43	
Pos	Directivity Factor	44	
Mes	LT360 - Zero Turntable CW	45	// Sends Table to Zero Position - Default 0.0
Mes	LT360 - Speed	46	// Resets Velocity to initial default
Rec	Recall curves	47	
Dis	Microphone Polar Plot Final	48	
		49	

Further sequence development

Microphone Polar Plot Substitution Method LinearX LT360

- To use this as a production sequence, remove the demo data recall steps:
  - 2 – Mes – Recall Demo Data and 48 – Rec – Recall curves.
- Adjust the Start Time to better match your surroundings in the Time tab of Ana Step 9
- There is additional example polar data included in the DATA folder within this sequence package that you can view by opening the .dat files in the Memory List. This data will be displayed on the "Microphone Polar Plot" display tab
- The sequence can be modified to run a complete 360 degree polar without mirroring the data. The following step changes are required:
  - 37 – Skip Last Acquisition – Change value from 179 to 359
  - 41 – Dis – Microphone Polar Plot – Uncheck **Mirror** in the polar plot window preferences and add 190 to 360 Normalized Curves to Polar Window
  - 42 – Mes – End of Loop – Step Configuration: Change 18 repetitions to 36
  - 49 – Dis – Microphone Polar Plot Final - Uncheck **Mirror** in both polar plot window preferences and add 190 to 360 Normalized Curves to Polar Windows

Microphone Polar Plot Physical Setup

When setting up a turntable and other hardware to make polar plots, there are several items to consider in the hardware setup:

- The microphone diaphragm face should be centered on the turntable platter center
- The microphone diaphragm should be centered on the center axis of the source speaker. The microphone should be perpendicular to the face of the source speaker.
    - See ***Figure 3*** *and* ***Figure 4***
- The shape of the microphone stand and mic clip should be small and rounded to minimize reflections
- The source speaker should be pole mounted and secured so that no changes in position can occur
- Make sure the boom arm of the mic stand does not hit any hardware as the turntable rotates. See ***Figure 3***
- A self-leveling “Plumb” laser, positioned at the center of the turntable with the laser pointing to the microphone diaphragm, will help when centering the microphone.

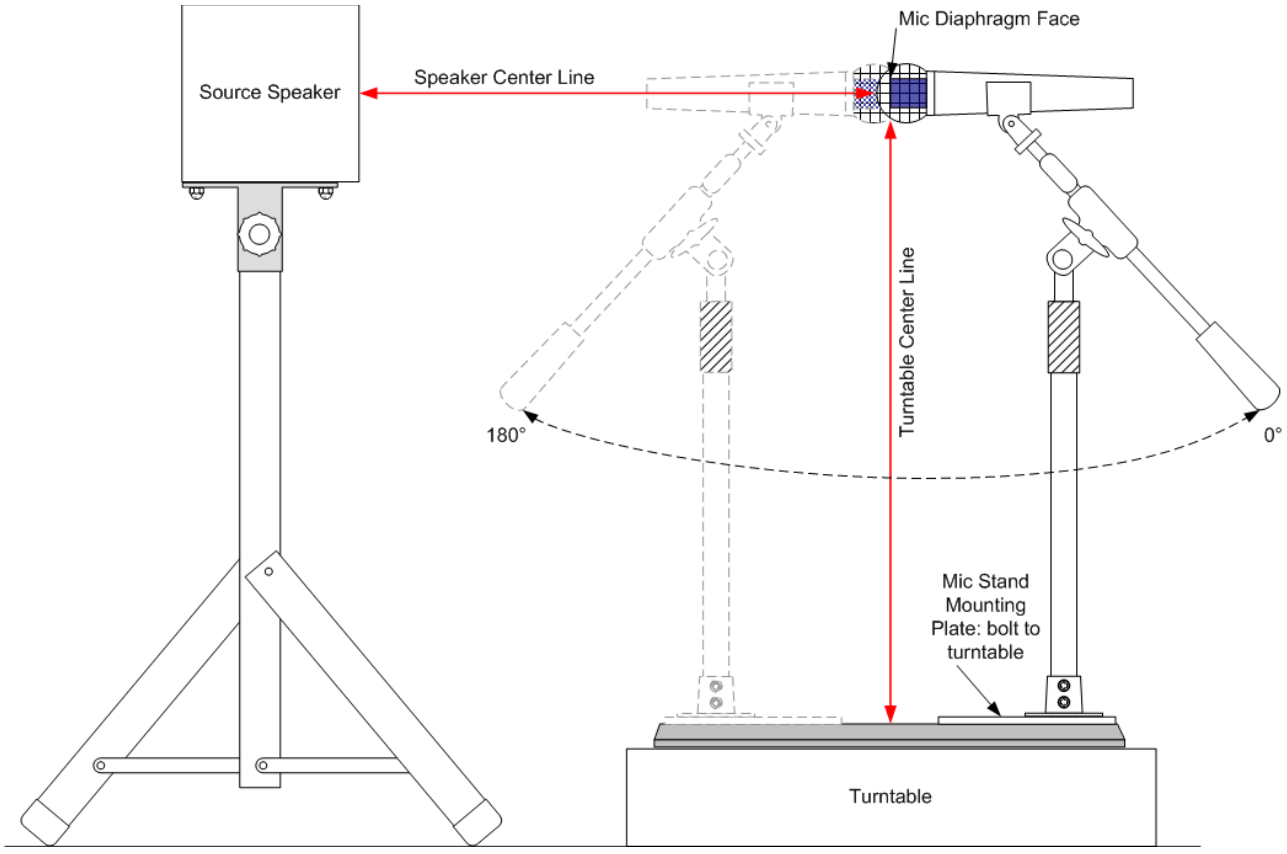

Figure 3: Polar Plot Setup

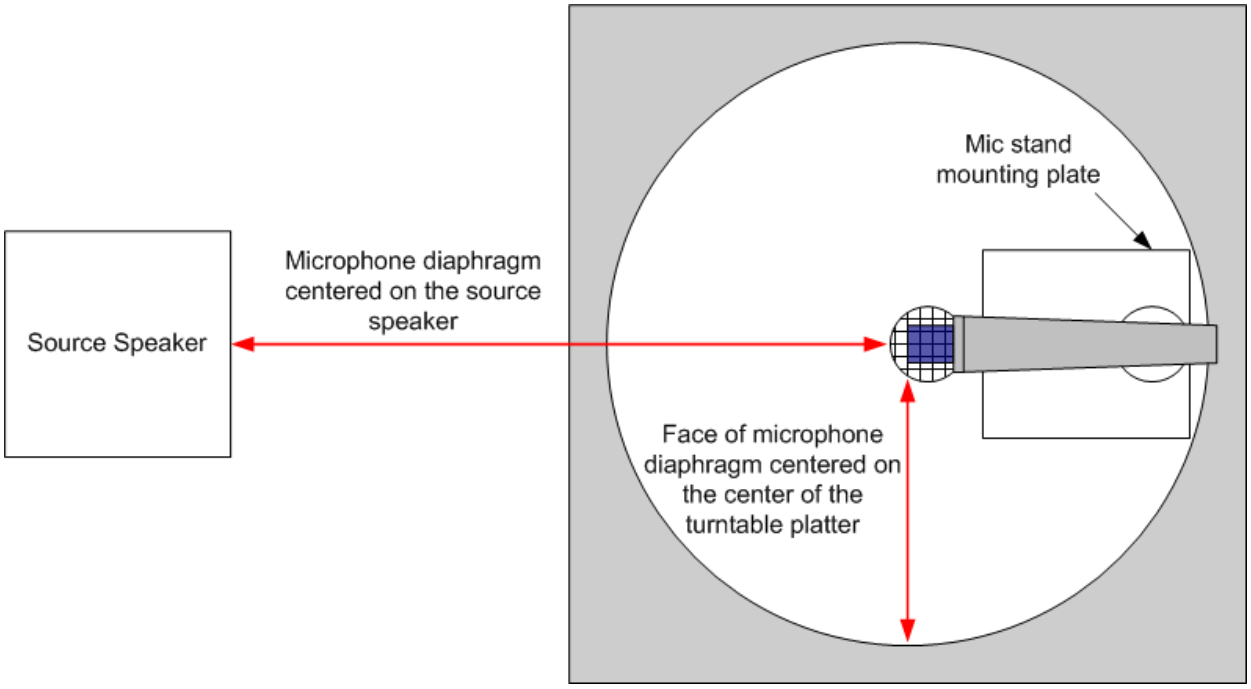

Figure 4: Polar Plot Alignment

Suggested Parts

- The mic stand pole should be a 7/8” diameter pipe in order to fit into the turntable base fitting noted below
- 7/8” ID Round Base Rail Fitting, 90°: This is not a standard item for mic stands. This and the mounting plate allow the mic stand to be mounted off-axis. The part number for the item used in the example is: 286090-1 Marine Round Base Rail Fitting, 90°.
- Speaker Stand 35mm (1.375") Pole Mount Adapter Bracket: This is used on top of a standard speaker tripod stand for mounting the source speaker. If you want to avoid drilling into the case of the source speaker, a mounting plate can be added to the bracket so the speaker can be “Strapped” in position.
- Microphone Flange Female: This is useful when mounting “non-standard” microphones on the mic stand. (Could be used to hold a MEMS mic mounted on a PC board.)
- Adjustable Length Boom Arm: This allows you to position the microphone so it is centered on the turntable base as well as to the source speaker
- Microphone Clip Quick Release: Allows you to quickly change between microphones
- Construction Laser: Used to align the microphone so it is precisely aligned to the turntable center and the source speaker
- Concentric Driver Source Speaker: The source speaker should be a single driver or a woofer with a concentric mounted tweeter: e.g., Genelec 8331A (powered) or KEF Q300/350 (unpowered)